MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

EMF4076 –ELECTROMAGNETIC INTERFERENCE
(EE, TE& MCE)

16th MARCH 2018
3:00 P.M. – 5:00 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Define Electromagnetic Interference (EMI) and state the THREE (3) aspects that need to exist in order for EMI to take place.

[5 marks]

(b) Briefly explain the TWO aspects of Electromagnetic Compatibility (EMC): Emission and Susceptibility.

[4 marks]

(c) Propose THREE methods to reduce capacitive coupling between parallel wires.

[3 marks]

(d) Consider four parallel wires; three of which are signal leads (lead-1, lead-2 and lead-3) and the fourth one is a common signal return lead (lead-G). Two ac voltage sources V_{s1} and V_{s2} are applied across lead-1 to lead-G and across lead-2 to lead-G, respectively. Assume the series resistance in loop-1 and loop-2 are negligible, and the load resistance of loop-3 is arbitrarily large. Draw the lumped element circuit model for the inductive coupling components.

[6 marks]

(e) A PCB trace with two traces is depicted as shown in Figure Q1(e). Trace 1 and 2 carries signal and the return is the ground plane. If Trace 1 is connected to input signal, derive the expression for the capacitively-coupled noise at Trace 2. Assume the termination impedance on all traces are high.

[7 marks]

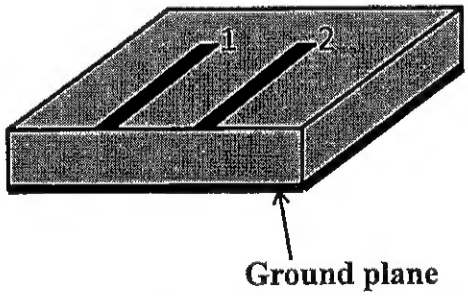

Figure Q1(e)

Continued . . .

Question 2

(a) With the aid of appropriate diagrams, explain the differences between single-point and multi-point grounding schemes. Give the merits and demerits of each grounding system.

[8 marks]

(b) Power line is as critical as ground in the propagation of noise in the electronic circuits.

(i) With the aid of the transmission line model diagram, explain how transient wave propagates in the power line.

[5 marks]

(ii) Illustrate with the aid of an equivalent circuit model, explain how power supply decoupling, using decoupling capacitors, can reduce this transient wave propagation.

[4 marks]

(iii) Besides using decoupling capacitors, how can this transient wave propagation be reduced?

[2 marks]

(c) For the circuit in Figure Q2(c), calculate the relative magnitude (in dB) of the ground noise coupled into the differential amplifier with respect to the signal voltage VS when R_{in} is 390 kΩ.

[6 marks]

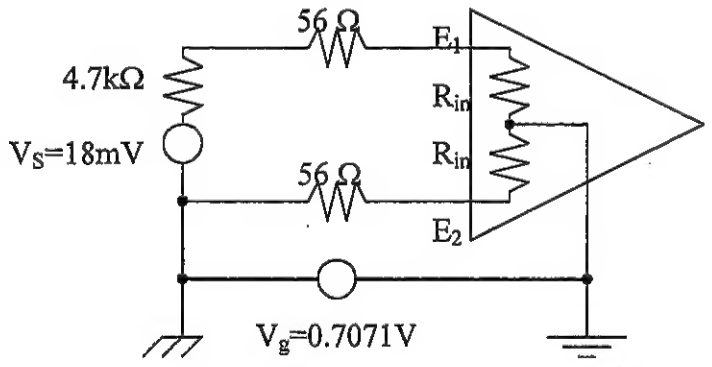

Figure Q2(c)

Continued . . .

Question 3

(a) Describe FOUR (4) steps to minimize the radiation due to current loop.

[6 marks]

(b) Define skin depth and its relationship with frequency and material properties of shielded enclosure.

[4 marks]

(c) Overall shielding effectiveness of a shielding material is determined by THREE (3) main factors. List them.

[3 marks]

(d) A wire carrying a 0.5 mA current at 250 MHz is parallel to a ground plane, at a height of 1 cm. The length of the wire is 2 m. Estimate the electric field strength at a distance r = 10 m above the ground plane (with the antenna oriented parallel to the wire). Calculate the voltage in dBμV that will be detected at the antenna terminals if the antenna factor is 12 dB.

[*Given the far-field expression for E-field due to a small current-loop of loop-area A, carrying a time varying current is $I_o e^{j\omega t}$ is: $|E_S| = 30\frac{k^2 I_o A}{r}$ where k is the propagation constant.]

[12 marks]

Continued . . .

Question 4

(a) Explain the significance of electromagnetic compatibility (EMC) regulations. State TWO standard making bodies for European EMC regulations.

[4 marks]

(b) A product is tested for CISPR 22 Class B radiated emission as shown in the Figure Q4(b). The distance between the measurement antenna and the product is 10m. The spectrum analyzer is connected to the measurement antenna with a 20m coaxial cable that has a loss of 0.15dB/m at 100MHz. The antenna factor at 100MHz is $5dBm^{-1}$. The CISPR 22 emission limit is tabulated in Table Q4(b).

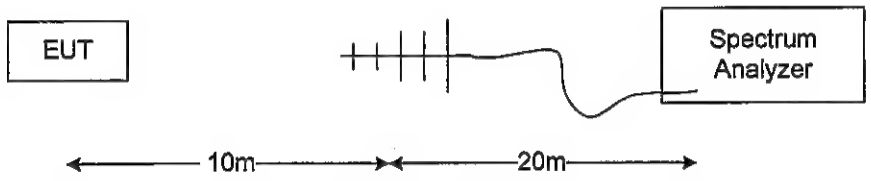

Figure Q4(b)

Table Q4(b)

CISPR Class B limit at 3m	
Frequency (MHz)	dBμV/m
30-230	40.5
230-1000	47.5

(i) Determine the 10m radiated emission limit at 100MHz in dBμV/m.

[2 marks]

(ii) If the spectrum analyzer indicates a level of 24dBμV at 100MHz, determine the level of received electric field at the antenna.

[4 marks]

(iii) Determine whether the product will pass or fail the CISPR 22 Class B test, and by how much.

[2 marks]

(c) With the aid of diagram, describe the measurement procedure for radiated emission test.

[13 marks]

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